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Analysis of the distribution of endemic and rare arthropods in high endemism areas of Algarve – South Portugal

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Summary

The study of several arthropod groups in high endemism areas (HEA) of Algarve, the Southernmost province of Portugal, has revealed endemic species and species not yet recorded for the Portuguese fauna. The list includes 3 species of Isopoda endemic to Algarve, to Portugal or to the Iberian Peninsula, 2 species new to Portugal and 2 species new to the Iberian Peninsula; 2 species of Pseudoscorpiones not yet cited to Portugal; 11 species of Pauropoda new to Portugal, including one new species probably endemic; 15 species of Collembola endemic to the Portuguese or to the Iberian Peninsula faunas (Gama et al. 1997) and 37 species and 5 subspecies of Staphylinidae endemic to Algarve.

With the exception of Collembola, which have been studied by us, the remaining groups have been submitted for study to several specialists.

These findings heighten the biological richness of these areas of high endemism in terms of conservation of biological diversity. The authors draw attention to the necessity to preserve or restore the biological value of these areas, encouraging the adoption of protective measures and the creation of research programmes that include the implementation of taxonomic studies and co-operation between taxonomists and ecologists in order to preserve the biodiversity of these areas.

Key words: Biodiversity conservation, soil arthropods, high endemism areas, endemic species, Algarve, South Portugal

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Introduction

Conservation biology has recently developed as a response by the scientific community to the biodiversity crisis caused by the exponential growth of human population. The natural world has been affected at a rapid rate by human activity to the extent that massive alteration of habitats and associated biological changes threaten the existence of millions of species and basic ecosystem processes. It is a new synthetic concept that combines the principles of the traditional academic disciplines, such as ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy, with the applied traditions of agriculture, forest management and allied fields to the maintenance of biological diversity throughout the world (Meffe & Carroll 1994).

The importance of biodiversity has been newly understood mainly after the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 and the creation of the Convention on Biodiversity (Wilson 1997). The Rio Convention stresses both pure conservation measures and sustainable use. Conservation measures must imply identification and preservation of sites, especially endemic sites. Measures for sustainable use must aim at keeping the soil biodiversity as high as possible in agricultural and forest soils, avoiding chemical treatments (Hagvar 1998). In fact the "new" conservation biology differs from traditional resource conservation in being motivated not only by economic, utilitarian philosophy (single-species issues), but by the need for conservation of entire ecosystems with all their biological components and processes (Meffe & Carroll 1994). In many cases this means developing compromises between conservation priorities and human needs (Primack 1993).

The most precious biological components of biodiversity (edaphic communities) from a conservation perspective are endemic biota which are particularly vulnerable to ecosystem disturbance. Endemic biota tend to occur in particular areas that represent high biodiversity spots, which must be considered of prime importance in nature conservation (Deharveng 1996).

Algarve, the Southernmost province of Portugal, is a special hot spot of biodiversity in the Iberian Peninsula where five well delimited ecological areas have been distinguished: Península de Sagres, Serra de Monchique, Barrocal, Parque Natural da Ria Formosa e Reserva Natural do Sapal de Castro Marim (Fig. 1). In these areas several endemic species of phanerogams (Rocha Afonso 1991) and Arthropods [Thysanura (Mendes 1985, 1992), Homoptera Cicadoidea Tibicinidae (Boulard 1982; Quartau 1995)] and Coleoptera Cicindelidae (Horn 1937; Serrano 1988, 1995)] have been pointed out (Table 1).

The study of the Collembolan populations from these areas of high endemism (HEA) is integrated in an EU project (1995-97) entitled "High Endemism Areas, Endemic Biota and the Conservation of Biodiversity in Western Europe". It has revealed 15 species endemic to Portugal or to the Iberian Peninsula and 23 species not yet referred to Portugal or to the Iberian Peninsula (Gama et al. 1997) (see also Table 2). Moreover, from our sampling in these areas, some interesting species of other arthropod groups have been found, which have been studied by specialists, some of them participating in this project (Table 3).

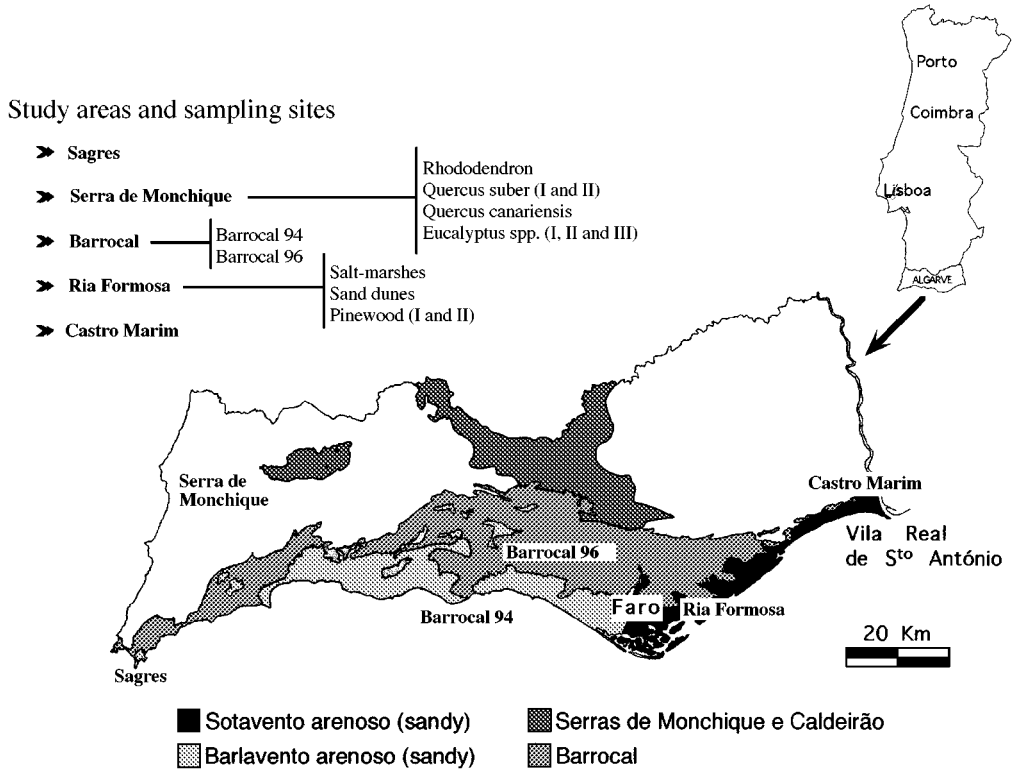

Fig. 1. High endemism areas (HEA) in Algarve and sampling sites.

Table 1. Endemic or rare plants and arthropods from high endemism areas in Algarve already previously known

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Phanerogams					
Iberis sampaiana Franco & P. Silva, 1963	E				
Biscutella vicentina (Samp.) Guinea, 1964	E				
Hyacinthoides vicentina (Hoffmanns & Link) Rothm., 1944	E				
Thymus camphoratus Hoffmanns & Link, 1809	E				
Diplotaxis vicentina (Coutinho) Rothm., 1940	E				
Cistus palhinhae Ingram, 1943	E				
Astragalus massiliensis (Miller) Lam., 1783	E				
Quercus canariensis Willd., 1809		R			
Euphorbia monchiquensis Franco & P. Silva, 1968		E			
Rhododendron ponticum L. ssp. *baeticum* (Boiss. & Reuter) Hand.-Mazz., 1762		IE			
Ilex aquifolium L., 1753		R			
Ophrys speculum Link ssp. *lusitanica* O. & A. Danesch			IE		
Dittrichia viscosa (L.) W. Greuter ssp. *revoluta* (Hoffmanns & Link) P. Silva & Tutin, 1973				E	
Tuberaria major (Willk.) P. Silva & Rozeira, 1964				E	
Thymus lotocephalus G. López & R. Morales, 1984			E		
Thysanura (Microcoryphia)					
Machilis sacra Mendes, 1976	E				
Machilis cf. *lusitana* Wygodzinsky, 1945		IE			
Machilinus rosaliae Mendes, 1977			E		
Bachilis multisetosa Mendes, 1977			E		
Dilta bitschi Mendes, 1976			E		

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria 0Formosa*	*Castro Marim*
Thysanura (Zygentoma)					
Ctenolepisma algharbica Mendes, 1978	E				
Ctenolepisma guadianica Mendes, 1992				IE	
Coletinia mendesi Wygodzinsky, 1980				IE	
Homoptera (Cicadoidea)					
Tettigeta josei Boulard, 1982			E		
Homoptera (Coccoidea)					
Kermes vermilio Planchon			R		
Coleoptera (Cicindelidae)					
Cicindela hybrida silvaticoides Horn, 1937	E				
Cephalota hispanica (Gory, 1833)					IE (Tertiary relict)

NOTES: (R) – Rare species (E) – Endemic species (IE) – Iberian endemic species
Phanerogams (Rocha Afonso, 1991) Thysanura (Mendes, 1985, 1992 and in litteris)
Homoptera Cicadoidea (Boulard, 1982; Quartau, 1995)
Homoptera Coccoidea (Passos de Carvalho, in litteris)
Coleoptera Cicindelidae (Horn, 1937; Serrano 1988, 1995)

Table 2. Endemic or rare Collembola species from high endemism areas in Algarve

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Microgastrura sensiliata Jordana, 1981		IE		IE	
Odontellina nivalis (Cassagnau, 1959)			M		
Deutonura atlantica Deharveng, 1982		E			
Deutonura coiffaiti (Deharveng, 1979) (*)		E			
Endonura baculifer (Deharveng, 1979) (*)		E			
Friesea acuminata Denis, 1925				A-M	
Friesea pseudodecipiens Arbea & Jordana, 1997		M			
Friesea ladeiroi Gama, 1959			A-M	A-M	A-M
Friesea stachi Kseneman, 1936			M		
Gamachorutes verrucosus Cassagnau, 1978		IE	IE	IE	
Fissuraphorura gisini (Selga, 1963)		A-M			
Mesaphorura arbeai Simón & Luciáñez, 1994		IE		IE	
Mesaphorura florae Simón & Luciáñez, 1994	IE				IE
Mesaphorura sp. 1	IE	IE			
Mesaphorura sp. 2	E	E			
Mesaphorura sp. 3	E	E			
Metaphorura denisi Simón, 1985			M		
Onychiurus penetrans Gisin, 1952		M			
Cryptopygus debilis (Cassagnau, 1959)	M	M	M	M	M
Folsomides pocosensillatus Fjellberg, 1993	A-M				
Folsomides xerophilus Fjellberg, 1993	A-M				
Proisotoma coeca Gama, 1961		E			
Proisotoma gisini Gama, 1964				E	

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Lepidocyrtus lusitanicus Gama, 1964		IE		IE	
Lepidocyrtus tellecheae Arbea & Jordana, 1990		IE			
Pseudosinella sp.					E
Troglopedetes cavernicola Delamare, 1944			E		
Willowsia sp.		E	E		
Arrhopalites microphthalmus Cassagnau & Delamare, 1953	M				
Stenacidia hystrix (Börner, 1903)			M		

NOTES: A-M – Atlantic-Mediterranean species E – Endemic species IE – Iberian endemic species
M – Mediterranean species (*) Not found in this project sampling

Table 3. Endemic or rare arthropods from high endemism areas in Algarve

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Isopoda					
Trichoniscoides machadoi Vandel, 1946 (•)			E		
Haplophthalmus siculus Dollfus, 1896 (•)			M		
Buchnerillo littoralis Verhoeff, 1942 (**)				A-M	
Armadilloniscus littoralis Budde-Lund, 1885 (*)				A-M	
Trichorhina anophthalma Arcangeli, 1935			IE		
Stenoniscus pleonalis Aubert & Dollfus, 1890 (*)				A-M	
Troglarmadillidium machadoi Vandel, 1946 (•)				E	
Paraschizidium olearum Verhoeff, 1917 (**)			R (M)		
Pseudoscorpiones					
Chthonius (*E.*) gibbus Beier, 1952	M	M	M		
Chthonius (*C.*) jonicus Beier, 1931 (*)	A-M				
Chthonius (*C.*) halberti Kew, 1916 (*)				Lusitanian	
Microcreagrina hispanica (Ellingsen, 1910)			M		
Geogarypus minor (L. Koch, 1873)	M	M			
Olpium pallipes (H. Lucas, 1846)	M			M	
Hysterochelifer tuberculatus (H. Lucas, 1846)			M		
Roncocreagris cf. *galeonuda* (Beier, 1955)		M			
Araneae					
Theridion simile C. L. Koch, 1836		IP			
Nigma puella (E. Simon, 1870)		IP			
Pauropoda					
Pauropus sp. (*)			"		
Allopauropus sp. (10 species) (*)			"		

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Symphyla	"	"	"	"	"
Chilopoda	"	"	"	"	"
Diplopoda	"	"	"	"	"
Protura	"	"	"	"	
Diplura					
Podocampa ceballosi (Silvestri, 1932)		M	M		
Parajapyx (P.) isabellae (Grassi)			C		
Dermaptera		*Rhododendron* flowers			
Embioptera	"		"		"
Psocoptera	"	"	"	"	"
Hemiptera	"	"	"	"	"
Thysanoptera	"	*Rhododendron* flowers and in other sites	"	"	"
Curculionidae	"	"	"	"	"
Staphylinidae		"	"	"	"
Cantharidae: *Rhagonycha* sp.		*Rhododendron* flowers			
Melyridae: *Atallus* sp.		*Rhododendron* flowers			
Nitidulidae: *Meligethes* sp.		*Rhododendron* flowers			
Alleculidae		*Rhododendron* flowers			

	Sagres	*Serra de Monchique*	*Barrocal*	*Ria Formosa*	*Castro Marim*
Chrysomelidae		*Rhododendron* flowers			
Diptera		*Rhododendron* flowers			
Hymenoptera Chalcidoidea		*Rhododendron* flowers			

NOTES: (R) – Rare species (A-M) – Atlantic-Mediterranean species IP – Iberian Peninsula (E) – Endemic species
(IE) – Iberian endemic species (M) – Mediterranean species (C) – Cosmopolitan species
(*) Recorded in Portugal for the first time (**) Recorded in the Iberian Peninsula for the first time
(•) Not found in this project sampling

Materials and Methods

The methods used in this study can be divided into two groups. The first one was the performance of an extensive bibliography search on published material from the Algarve region; the second method consisted in real fieldwork integrated in a broader research project (see above). In this project five well delimited areas were chosen as representative of landscape units from the Algarve province (Fig. 1).

At each unit soil samples were taken in several periods between 1994 and 1996. The extracted biological material was then identified by specialists (Collembola were identified in our laboratory and other groups in different laboratories across Europe).

For more details concerning biotope characterization, sampling and soil analysis please refer to Gama et al. (1987).

Results and Conclusions

Most of the endemic or rare species and the species with a Mediterranean or Atlantic-Mediterranean distribution belonging to the arthropod groups figured in Table 2 and Table 3 have been sampled by us in high endemism areas of Algarve (see Introduction):

Collembola (Table 2): Only two endemic species, *Deutonura coiffaiti* and *Endonura baculifer*, known from Porto de Lagos (Monchique), have not been found in our sampling. Among the other endemic species we emphasise *Deutonura atlantica* known from several localities of Portugal and the two paleoendemics, *Troglopedetes cavernicola*, previously found exclusively from caves in the South of Portugal and recorded here in soil, and *Gamachorutes verrucosus*, a very interesting Iberian endemic which is recorded for the first time since its original description in 1978. *Pseudosinella* sp. and *Willowsia* sp. as well as *Mesaphorura* sp. 2 and *Mesaphorura* sp. 3 may be new to science and probably represent neoendemics.

Other collembolan species present a restricted distribution: *Odontellina nivalis* (= *Odontellina bisetosa* Selga, 1963) is a rare Pyreneo-iberic species. *Friesea acuminata* is characteristic of littoral habitats and has been recorded from England, North Adriatic Sea (Island of Krk, Venice and Trieste) and recently from Algarve. *Friesea pseudodecipiens* has been recorded in Italy, Hungary, Crete, Spain, Morocco and lately in Algarve. *Friesea ladeiroi* is known only from Portugal and Madeira Island and *Friesea stachi* from the Oriental Carpathians (Rumania) and Morocco and it was recently collected in Algarve. *Fissuraphorura gisini* has been recorded from Spain and the Canary Islands and recently from Algarve and *Metaphorura denisi*, although previously recorded only from the septentrional part of the Iberian Peninsula, may also exist in Crete and France (Arbea, 1987) because it has been confused with *M. affinis*. This species was found recently by us in Algarve. *Cryptopygus debilis* was considered an endemic to beech forest from the French Pyrenees but it also exists in the Iberian Peninsula and in Crete. *Folsomides pocosensillatus* and *F. xerophilus* have been recorded only from the Canary Islands and Algarve. *Arrhopalites microphthalmus*, recorded until now only in France (surroundings of Toulouse) and the North of Spain, was found recently in Algarve and *Stenacidia hystrix* is a rare species which has been cited from the Iberian Peninsula and Eolic Islands.

Isopoda (Table 3): *Trichorhina anophthalma* is an Iberian endemic cited from Serpa and Setúbal (Portugal), Malaga and Algésiras (Spain) and *Paraschizidium olearum* was known until now only from Minorca. Three species represented in Ta-

Table 4. Endemic Staphylinidae species from high endemism areas in Algarve

	Costa Vicentina	*Monchique*	*Barrocal*	*Ria Formosa*
Astenus (A.) algarvensis Coiffait, 1968			Loulé	
Astenus (A.) algarvensis virgo Coiffait, 1968			Alportel	
Astenus (s. str.) *fageli luteomarginatus* Coiffait, 1968			Alportel	
Bythinus anguliceps Reitter, 1885		Serra de Monchique		
Cylindropsis (s. str.) *littoralis* Coiffait, 1969	Albufeira, Bordigueira	Alferce	Algoz, Alportel, Loulé, St.ª Catarina	Tavira
Entomoculia (S.) vicinus Coiffait, 1964			Loulé (St.ª Bárbara de Nexe)	
Geomitopsis lusitanicus Coiffait, 1965	Portimão			
Geostiba (L.) plicatella subopacula Bernhauer, 1909				Faro
Hesperotyphlus algarvensis Coiffait, 1964		Porto de Lagos		
Hesperotyphlus lusitanicus Coiffait, 1978	Algarve			
Holotrochus lusitanicus Coiffait, 1978		Barranco-do-Velho		
Leptobium doderoi Gridelli, 1926	Portimão			
Lusitanopsis (s. str.) *littoralis* Coiffait, 1969	Albufeira	Alferce	Alportel, Loulé	Tavira
Lusitanopsis (s. str.) *monchicus* Coiffait, 1969		Porto de Lagos		
Lusitanopsis algarvensis Coiffait, 1965			Loulé	
Mayetia (s. str.) *algarvensis* Coiffait, 1961			Silves	
Medon lusitanicum Coiffait, 1969			Algoz	
Mesotyphlus (A.) affinis Coiffait, 1964			Loulé	
Mesotyphlus (A.) albufeirensis Coiffait, 1970	Albufeira			
Mesotyphlus (A.) bordigheirensis Coiffait, 1970	Bordigueira			
Mesotyphlus (A.) campus Coiffait, 1964	Boliqueime			
Mesotyphlus (A.) furcatus Coiffait, 1964		Porto de Lagos		
Mesotyphlus (A.) inversus Coiffait, 197			St.ª Catarina	
Mesotyphlus (A.) montanus Coiffait, 1964			Loulé (Querença)	
Mesotyphlus (A.) paeonius Coiffait, 1964			Loulé (Amendoeira)	

	Costa Vicentina	*Monchique*	*Barrocal*	*Ria Formosa*
Mesotyphlus (A.) rupestris Coiffait, 1964			S. Brás de Alportel (Vilharinhos)	
Mesotyphlus (A.) siliquus Coiffait, 1964			S. Brás de Alportel (S. Romão)	
Mesotyphlus (A.) silvensis Coiffait, 1964			Silves	
Mesotyphlus (A.) simplex Coiffait, 1964			S. Brás de Alportel (S. Romão)	
Mesotyphlus (D.) brevis Coiffait, 1970	Bordigueira			
Mesotyphlus (D.) pervincus Coiffait, 1964			Estoi	
Mesotyphlus (D.) vicinus Coiffait, 1964			St.ª Bárbara de Nexe	
Mesotyphlus (s. str.) *maritimus* Coiffait, 1964		Amoreira		
Mesotyphlus (T.) rivularis Coiffait, 1964		Porto de Lagos		
Mimogonia europaea Coiffait, 1978			St.ª Bárbara de Nexe	
Nazeris algarvensis Coiffait, 1971		Serra de Monchique		
Paratyphlus (s. str.) *algarvensis* Coiffait, 1964			Almancil, St.ª Bárbara de Nexe	
Paratyphlus (s. str.) *brazensis* Coiffait, 1964			S. Brás de Alportel	
Paratyphlus (s. str.) *carvoeirensis* Coiffait, 1970			Carvoeiro	
Paratyphlus (s. str.) *delicatulus* Coiffait, 1964			S. Brás de Alportel, S. Romão	
Pselaphostomus franzi Besuchet, 1961		Monchique		
Pseudobium gridellii ibericum Coiffait, 1982			Alportel, Silves	Tavira
Quedius (M.) crassus var. nigricans Gridelli, 1924		Monchique		
Xantholinus algarvensis Coiffait, 1972		Caldas de Monchique, Porto de Lagos		

ble 3 have not appeared in our sampling: *Troglarmadillidium machadoi*, an endemic cited exclusively from Faro, *Trichoniscoides machadoi*, endemic to Portugal and *Haplophthalmus siculus* recorded from the Iberian Peninsula, Sicily and Algeria. The remaining species show an Atlantic-Mediterranean distribution.

Pseudoscorpiones (Table 3): Among the 9 species appearing in our samples, *Chthonius* (C.) *halberti* and *Chthonius* (C.) *jonicus* are cited for the first time in the Portuguese fauna: The first species has a Lusitanian distribution and the second was known from the Oriental Mediterranean, having been recently discovered in the Canary Islands (Manhert – personal communication). The remaining species in Table 3 present a Mediterranean distribution.

Araneae (Table 3): Most of the species collected in the flowers of *Rhododendron ponticum* L. ssp. *baeticum* (Boiss. and Reuter) Hand. – Mazz. (Serra de Monchique) have a wide distribution, only *Theridion simile* and *Nigma puella*, figured in Table 3, are restricted to the Iberian Peninsula.

Pauropoda (Table 3): Our sampling has revealed one species of the genus *Pauropus* and 10 species of *Allopauropus*, among them one new species probably endemic. All these taxa are new to Portugal.

Diplura (Table 3): *Podocampa ceballosi* is known from several localities in the meridional half of the Iberian Peninsula and from the North of Africa. One cosmopolitan species *Parajapyx* (P.) *isabellae* was found in the Barrocal, and in Serra de Monchique, and another species, belonging probably to the genus *Japyx*, was also collected.

Staphylinidae: It is the richest family of all animal groups with a huge number of endemics already recorded for Western Europe. Table 4 shows the endemic species and subspecies from Algarve which were obtained from the database of D. Drugmand (*in litteris*). Among these 39 species and 5 subspecies, 1 species exists in Costa Vicentina, 11 species and 1 subspecies in Monchique, 22 species and 3 subspecies in Barrocal, and 2 species and 2 subspecies in Ria Formosa.

The remaining groups of Myriapoda and the other families of insects cited in Table 3 have not yet been identified.

Although the number of the remaining arthropod endemics recorded in this paper will most probably increase in the future, the actual knowledge of them reveals that Staphylinidae must be the most diversified group in Algarve.

The results obtained in this work suggest that areas of high endemism in Algarve, supporting a great variety of endemic and rare species of arthropods, should be considered a priority for conservation (Deharveng 1996).

These areas are constantly being threatened by several stress factors such as reafforestation with eucalyptus (a critical problem in Serra de Monchique), forest fires and by uncontrolled touristic development (a serious threat in coastal areas). In the face of this situation, well established plans of conservation are needed to avoid habitat degradation and local loss of biodiversity (Gama et al. 1997). The major threat to biological diversity is the loss of habitat and the most important means of protecting biological diversity is preserving habitat (Primack 1993). Natural ecosystems can easily be destroyed, but they cannot be created and at best only partially restored (Meffe & Carroll 1994). Nevertheless, as species are a very important and integral part of the ecosystems, there is a vital need for more taxonomic scientists to study, classify and protect the world‘s biological diversity.

In fact, only a small percentage of the living species are known to science. About 1.5 million species have been described and at least twice that number of species re-

main to be described, leading to a conservative estimate that there are about 5 million species worldwide (Primack 1993). With respect to arthropods, which are by far the most diversified of living organisms, their species richness cannot be measured even at local scale in temperate forest soils because of a lack of taxonomists (Deharveng 1996). However, taxonomists must collaborate with ecologists in order to apply their work to the issues of conservation and of sustainable use of species and habitats. Much greater cohesion between taxonomy and ecology is required if we are to present convincing arguments to save the diversity on our planet (Prance 1998).

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References

Arbea, J. (1987) Colembolos de Navarra. Taxonomia, Distribucion y Ecologia (Insecta, Collembola). Ph.D. Thesis, University of Navarra, Spain.

Boulard, M. (1982) Les cigales du Portugal, contribution à leur étude (Hom. Cicadidae). Annales de la Société Entomologique de France (N.S.) 18, 181–198.

Carmona, M. M. (1985) Sobre a biologia de *Kermes vermilio* Planchon (Homoptera: Coccoidea). Boletim da Sociedade Portuguesa de Entomologia 2, 433–444.

Deharveng, L. (1996) Soil Collembola diversity, endemism, and reforestation: a case study in the Pyrenees (France). Conservation Biology 10, 74–84.

Gama, M.M. da, Sousa, J.P., Ferreira, C.,Barrocas, H. (1997) Endemic and rare Collembola distribution in High Endemism Areas of South Portugal: A case study. European Journal of Soil Biology 33, 129–140.

Hagvar, S. (1998) The relevance of the Rio-Convention on biodiversity to conserving the biodiversity of soils. Applied Soil Ecology 9, 1–7.

Horn, W. (1937) Über eine neue Rasse der *Cicindela hybrida* L. aus Portugal. Natuur-historisch Maandblad 26, 94–95.

Meffe, G.K., Carroll, C. R. (1994) Principles of Conservation Biology. Sinauer Associates, Inc., Sunderland, Massachusetts.

Mendes, L.(1985) Nota preliminar sobre os Tisanuros Microcoryphia e Zygentoma do Algarve (Portugal). Boletim da Sociedade Portuguesa de Entomologia supl 1, 239–262.

Mendes, L. (1992) New data on the Thysanuran (Microcoryphia and Zygentoma: Insecta) from the Guadiana River Valley in Algarve (Portugal). Arquivos do Museu Bocage N.S. 2, 275–286.

Prance, G. T. (1998) Taxonomy in Ecology. British Ecological Society, Bulletin Feb. 98, 8–10.
Primack, R. B. (1993) Essentials of Conservation Biology. Sinauer Associates, Inc., Sunderland, Massachusetts.
Quartau, J. A. (1995) Cigarras, esses insectos quase desconhecidos. Correio da Natureza 19, 33–38.
Rocha Afonso, M. L. (1991) Plantas do Algarve. Serviço Nacional de Parques, Reservas e Conservação da Natureza, Lisboa.
Serrano, A. R. M. (1988) A synonymic note. Boletim da Sociedade Portuguesa de Entomologia. 100, p. 1.
Serrano, A. R. M. (1995) Description and natural history of tiger beetles larvae (Coleoptera Cicindelidae) from Castro Marim – Vila Real de Santo António region (Algarve, Portugal). Arquivos do Museu Bocage N. S. 2, 555–606.
Wilson, E. O. (1997) Systematics in Asia. Taxonewsia 1, 3.